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ABSTRACT

The framework of the new British Columbia mathematics curriculum for grades 1-7 includes willingness to take risks and expanded tolerance of ambiguity as goals of mathematics learning. Two projects in Victoria (British Columbia) elementary schools explored ways to promote positive student attitudes toward mathematical tasks and problem solving. During the first several months of school, six first-graders were identified as being reluctant or unwilling to take risks during mathematics instruction. Open-ended tasks with multiple solutions or methods of solution were expected to stimulate curiosity, group discussion, and risk taking. Once or twice a week, several open-ended activities were presented to the six students as a group or in smaller groups. Over time, the teacher noted positive changes in the classroom behavior of four of the students, who became more willing to ask questions and volunteer answers. In a second project, a self-assessment checklist that included statements about mathematics attitudes was completed by students in grades 6-7 at the beginning and end of the school year. During the year, open-ended tasks were included during mathematics instruction whenever possible. At the end of the year, improvements were noted in students' attitudes toward mathematics and problem solving, and students' comments indicated that they enjoyed solving problems in different ways and having the opportunity to explain their thinking. (SV)

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Teacher-Centered Projects: Confidence, Risk Taking and Flexible Thinking (Mathematics)

Werner W. Liedtke

The framework of the new mathematics curriculum includes willingness to take risks and growth in tolerance of ambiguity as goals of mathematics learning. What might teachers do to reach these important goals? The results from two projects provide a few hints for possible action.

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Introduction

The *Mathematics K to 7—Integrated Resource Package—IRP* (Ministry of Education 1995), states that becoming mathematically literate involves developing a positive attitude. According to the IRP, research from provincial assessments has emphasized the direct association between students' attitudes and their levels of performance. It is suggested that, "Mathematics activities should engage the interest and imagination of all students so that they are willing to take risks, grow in their tolerance of ambiguity, and achieve high levels of development in their mathematical thinking" (p. 2). Willingness to take risks requires a high level of confidence.

The framework of the IRP identifies one of the major goals of mathematics teaching as developing mathematical literacy. Three components of this goal include developing positive attitudes, becoming mathematical problem solvers and reasoning mathematically. Greenwood (1993) includes the following notions as part of mathematical thinking and mathematical power: "when a strategy you are using is not working, you should be willing to try another strategy instead of giving up" and, "you should be able to extend, or change, a problem situation by posing additional conditions or questions" (p. 144). Standard 10 in the Curriculum and Evaluation Standards (National Council of Teachers of Mathematics,1989) identifies the following components of mathematical disposition, "willingness to persevere in mathematical tasks" and "flexibility in exploring mathematical ideas and trying alternative methods in solving problems" (p. 233). These references indicate that flexibility is an important part of mathematical literacy.

The studies reported in this paper focus on two main questions:

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A. *What can a teacher do to foster the development of confidence?*

B. *What type of classroom settings, tasks and discussions might make contributions to reaching this important goal?*

The Projects

In order to try to find answers to questions A and B, two long term projects were planned; one for grade one, the other for grade six and/or seven. A small grant was received from Education Renewal. This money was used to pay for teachers-on-call while meetings were held throughout the school year.

Four teachers were contacted prior to the 1996/97 school year. Personal reasons and an assignment of a new grade were responsible for two negative responses. Meetings during the summer with one primary and one intermediate teacher were used to introduce the questions, share relevant background information and discuss possible actions. After an agreement to proceed was reached, permission was sought by the teachers and granted from the Victoria School Board.

It was planned that the activities in the classrooms were to be teacher-directed, without any major or special contributions connected to teaching from any person. Activities were to be based on materials that were part of the classroom setting. Any assessment instruments or strategies were to be of the kind and type available to every classroom teacher. Any outside assistance was to be in terms of coordination and provision of resources. Regular meetings were planned to look-back, to discuss progress and to plan for the month ahead. During the final meeting the collected data were examined and tabulated. Possible ways of sharing the procedures and results were discussed.

Project A—Confidence and Risk Taking.

The first glance at the make-up of the grade one class indicated that assistance would be required for part of this project. Although it would be possible to carry out the planned observations to identify students who were unwilling to take risks during the first part of the year, several special needs and quite a few ESL students put a very heavy demand on preparation and teaching time. Assistance would be required for the second part that involved the presentation of activities to these students. Fortunately, a very capable work study student, a senior in the Faculty of Education, became a valuable member of the project team. This student assisted with the observations, helped with the collecting of relevant information, and presented activities, to students in various settings.

By the end of November six students, three boys and three girls, were identified as being reluctant and/or unwilling to take risks. Their level of confidence seemed to dictate a reluctance to participate in discussion, not to volunteer information, nor to raise a hand to ask for more information. Further observations and follow-up discussions were used to ensure that this apparent lack of confidence was not confused with reflective behavior.

A conclusion from an article entitled, *First-and Second-Grade Students Communicate Mathematics* (Spungin, 1996) became the framework for the tasks or activities that were collected and presented. The author concludes that tasks with multiple solutions or methods of solution promote curiosity, demonstrate respect for all ideas by encouraging contributions from all students, since they are best in stimulating discussion, debate, creativity and risk-taking. The author provides several examples of activities that conclude by making the following suggestions to students: *Think again. Is another answer possible?* For the tasks that became part of this project this approach was revised to: *What is another possible answer?* or *What other answers are possible?* The main goal was to communicate to the students that, *Whatever you do or whatever you say is correct, as long as you can explain and provide a reason for what you are doing or what you have done.*

Once, or twice a week if the classroom setting warranted, the selected activities were presented to the six students who would work in one large group or smaller groups of two or three. Whenever possible, sample reactions and responses that were suggestive of risk taking were noted and recorded. Those recordings as well as reflections about these recordings became part of the discussion during the meetings.

Changes in behaviour were observed, especially in four out of the six students. It was satisfying to observe a hand going up for the first time, a question being asked, or more information being sought. It was even more satisfying to see these behaviors observed in the classroom setting. According to the classroom teacher the behaviours by the other two students also indicates some growth. However, these changes were subtle and therefore a little more difficult to observe unless someone had continuous contact over an extended period of time.

A classroom setting is very complex and many factors can contribute to changes in behavior. However, it was concluded that the settings that were created allowed these participants to feel safe, enjoy themselves and as a result take risks. This behavior transferred to the classroom setting.

Project B—Flexible Thinking.

Data collected during the early part of the school year from each of the grade six/seven students that were part of this project included responses to the *Sample Self-Assessment Checklist* from the *Mathematics K to 7 Integrated Resource Package* (Ministry of Education, 1995, p. 246). These responses along with the solutions for several problems were placed into each student's portfolio, a routine procedure for this classroom.

During the 1996-97 school year the students carried on with the regular mathematics program. Whenever possible, tasks were introduced that could create in students an awareness of the fact that there may exist different ways to solve many problems; many questions can be answered correctly in different ways; answers can or should be considered correct if the thinking to arrive at them makes sense and can be justified or explained; and it is unlikely that there exists a 'best' strategy to solve some problems and play some games.

During regular meetings that were held throughout the year, a brief look was taken at what had been done and the content for the coming months was examined with a focus on related problems, tasks and games that would meet the criteria of the project. A capable work study student not only assisted with the search for suitable tasks, but visited the classroom and carried out observations.

To find out whether the inclusion of the special types of problems throughout the school year had an effect on how students view and/or think about mathematics, the IRP Self-Assessment Checklist was administered again during the last month of the school year. The comparison of the responses for each student focused on the statements that related to problem solving and attitudes, since these were the major concern of this project. The checklist consisted of items such as:

Statement #1 • *Sometimes I don't know what to do when I start a problem.*

Statement #4 • *I usually give up when a problem is really hard.*

Statement #11 • *There is always a best way to solve a problem.*

Students were required to place a checkmark on a scale between the statements:

I am not good at mathematics . . . and . . . I am good at mathematics.

If changes in attitude toward mathematics learning were observed, students were asked to suggest why they thought that might have been the case. An analysis of the responses includes the following observations:

- Eight students who at the beginning of the year responded with a yes to *Sometimes I don't know what to do when I start problems* changed their replies.
- Five students changed their answers from yes to the statement, *I usually give up when a problem is really hard.*
- The greatest change in responses occurred for the statement, *There is always a best way to solve a problem.* Eleven students changed their answers from the yes that was elicited at the beginning of the year.
- The second response for ten of the students moved closer toward the statement about being *good at mathematics.*

During the final meeting the question, *Can some of the positive outcomes be attributed to the implementation of the project?* was posed. We believed this to be the case and concluded that an awareness by a teacher of the possible value of open-ended tasks and relating these types of settings to specific components of the curriculum throughout the year can have a positive impact on students' thinking about mathematics, even in the latter part of being in elementary school. This conclusion was supported by some of the comments students supplied in response to providing reasons for changing their opinions about viewing mathematics. These comments made reference to: *learning new ways of looking at problems; enjoying solving problems in different ways; valuing the opportunity to explain thinking;* having *learned to show answers;* and *having learned to do it rather than just providing an answer.* Some of the observations made while students played thinking games indicated that many enjoyed the task of looking for different strategies and then attempting to compare these.

Discussion and Suggestions

The projects that have been outlined are representative of the type of action research that connects me with teachers, their students and learning outcomes related to mathematics teaching, learning and assessment. Without classroom teachers as willing participants these type of projects would not be possible. Small amounts of money and an enthusiastic senior education student as an assistant can contribute greatly to the ease of implementation. The results from these type of projects can yield valuable information for classroom teachers. Over the years the contacts and connections with schools have been a very valuable experience. They have provided me with a vast repertoire of observations, responses from students, vignettes, and teaching experiences at that level that have become a valuable part of on-campus courses. Perhaps the benefits for the classroom teachers were few, other than having someone teach lessons for them, exchanging information about students and mathematics learning and an occasional lunch. In

recent years, small amounts of money received from Educational Renewal made it possible to free teachers for meetings during the day. The widespread benefits that can result from projects that involve teachers, their students and the Faculty of Education can provide a strong argument for having the Faculty attempt to negotiate for a reinstatement of the Education Renewal Fund or initiate actions to establish a similar source for such type of action research.

Over the years I have been very fortunate to have had senior students who, as part of the existing work-study programs, become valuable assistants. On many occasions I benefited from their enthusiasm. They benefited from observing teachers, students and working with students. There is no doubt in my mind that their willingness to go beyond the job descriptions by getting involved in the schools where the projects took place served them well as they applied for teaching positions. I believe this co-op type experience contributed to having them become valued ambassadors of our Faculty of Education and valuable members of the profession. If the Faculty is able to re-establish a fund for action research in schools, perhaps preference for awarding monies should be given to projects that involve senior students, even some who do not qualify for an existing work-study program.

The project on confidence yielded supporting data for the notion that instructional strategies that involve open-ended tasks and settings can stimulate risk-taking. Since that is the case, and since such strategies might be appropriate for early intervention and could help prevent failure in the future or help reduce the number of students who find themselves ending up in what the Ministry labels the 'grey area,' specific implementation hints should be included for teachers under Suggested Instructional Strategies in the IRP. An examination of the content that is presently entered under that heading is of a very general nature and is not suggestive of specific teaching moves or strategies. Since the majority of elementary teachers do not have a mathematics nor a strong mathematics education background, the more specific the suggestions that are provided, the more beneficial it can be for the students and their quest for acquiring numeracy and mathematical literacy. Both of the projects yielded information about teaching strategies that are appropriate for inclusion in future editions of the IRP. The inclusion of strategies of this type could assist with reducing the gap that exists between developing curriculum standards and implementing them in the classroom, which according to Rotberg et al., "we have always tended to underestimate" (1998, p. 462).

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